



IZADI-NANO2INDUSTRY

Nano-reinforcements added and  
dispersed via master-pellets in a new, low  
cost and safe gravity casting process

Speaker

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*“Nanotechnology based solutions for enhanced products and  
processes in existing industrial manufacturing plants”*

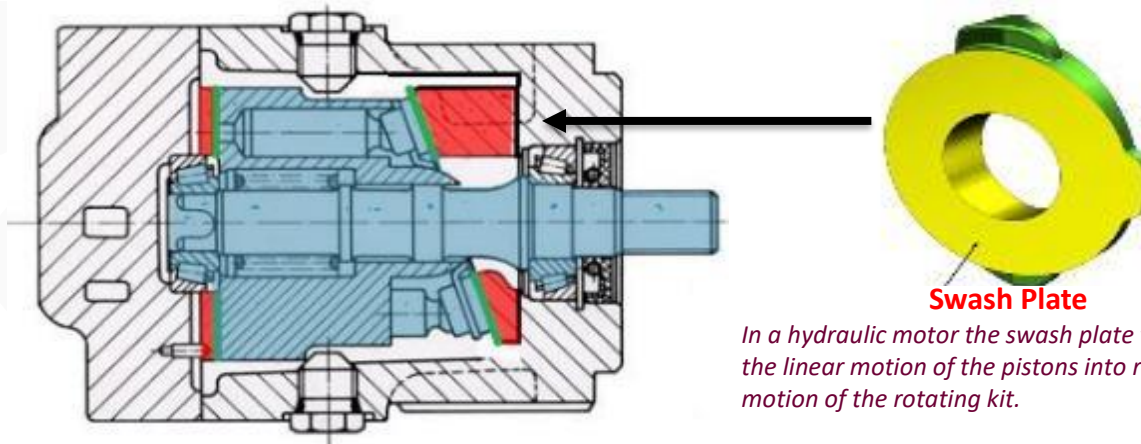
*Workshop*

Amsterdam (NL) - October 04th - 2018

# Nanoreinforced Ductile Iron castings

## Main features

Technology	Requirements	Sector	IZADI-NANO2INDUSTRY		
			Demonstrator Component	Pilot (TRL7)	Early Adopter
Incorporation of nanoparticulates into the Ductile cast iron. MASTERPELLETS for the production of nano-reinforced iron castings	Increased Hardness, wear and tensile properties	Construction Agricultural machinery	<b>Swash plate of hydraulic motor.</b> Bonfiglioli Riduttori (IT)	HARDcast (Sand casting)	Fonderie Mora Gavardo Lombardia (IT)



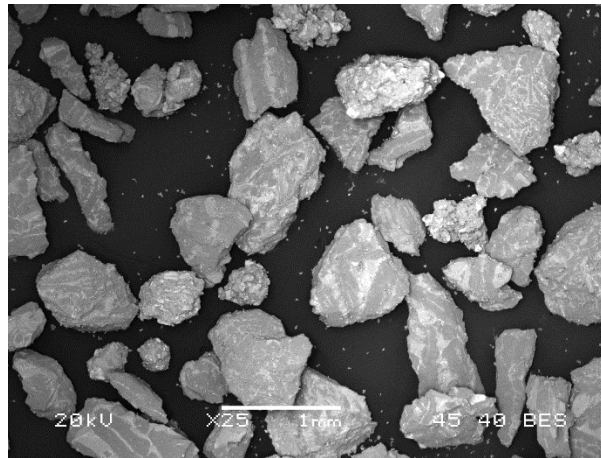
*In a hydraulic motor the swash plate translates the linear motion of the pistons into rotary motion of the rotating kit.*

# Nanoreinforced Ductile Iron castings

## Main features. Development of masterpellet concept

### MASTERPELLET (MP)

“Granulated powder materials containing iron and nanoreinforcement and with a size of individual granulates ranging from 0.2 to 0.7mm”



### Main features:

- Nanoparticulates are embedded in a Fe matrix. Safe by design approach.
- High contents of nanosized carbide and oxide nanoparticulates. (>40 wt.%)
- Easy and safe to handle in a foundry environment
- Compatible with DCI industrial casting process procedures.

# Nanoreinforced Ductile Iron castings

## Objectives of Pilot Plant scale trials

- Selection of nanoreinforcement for the demonstrator, swash plate.
- Testing and validation of the masterpellet concept . Safe by design approach
- Development of a process for the incorporation of nanoreinforcements into ductile iron castings suitable for industrial environment.
- Guarantee the robustness of the process, dispersion of reinforcements, safety issues, machining operations, feasibility of the concept for an industrial foundry.
- Final process optimization and performance checking. Production and testing of swash plates.

# Nanoreinforced Ductile Iron castings

## Trials at pilot scale

Main objectives:

- To **select** the nanoreinforcement for the production of swash plates.
- To cast samples to check the **homogeneity of the distribution** of the nanoreinforcements and the **robustness** of the process.
- To analyse the **actual influence** of both nZrO<sub>2</sub> and nanoTiC particulates on the performance of the castings. Hardness, strength, bench testing ....
- To define the recipe and casting procedure for industrial castings.
- Delivery of 10 swash plates for bench tests



# Nanoreinforced Ductile Iron castings

## Trials at pilot scale

### Main findings

- Incorporation of nanoparticulates in inoculation step OK (>0.03%)
- Safe by design approach OK
- Use of indirect methods to identify nanoparticulates within the DCI matrix
- Bench tests by BRI: Increase in mechanical properties or hardness has no relevant influence on motor efficiency.

Material	0.2% PS (MPa)	UTS (MPa)	Elong. (%)	Hardnes s HB
EN1563 (2000)	420	700	2.0	250-311
IZADI-800 (nTiC)	544	873	6.5	295
IZADI-900 (nZrO2)	557.5	933.5	5.5	305

# Nanoreinforced Ductile Iron castings

## Trials at FMG

Main developments in 2018

.- Construction of the mould and First batch of **swash plates** for **reference** purposes. (Material EN-GJS 700-2) (UTS 739 MPa)

**Second batch** with nanoTiC and nZrO<sub>2</sub> particulates UTS 750-760\*

Third batch with nZrO<sub>2</sub> following IZADI procedure.

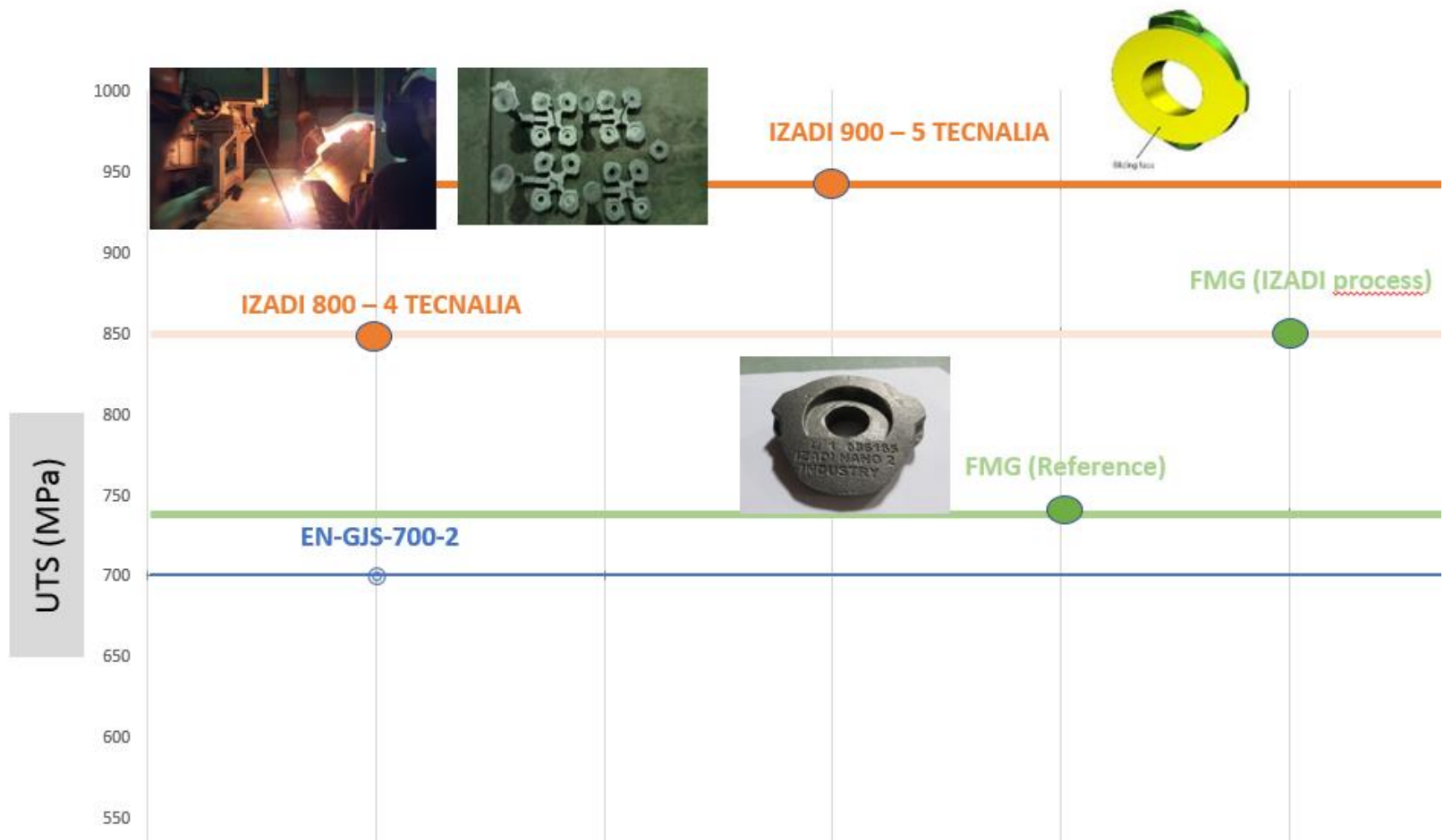
**UTS 852 MPa\***

\*(Lower Zr or Ti content increase than foreseen in swash plates).

**Fourth batch foreseen in October 18 week 40.**

# Nanoreinforced Ductile Iron castings

## Trials at FMG





# Nanoreinforced Ductile Iron castings

## Exploitation Routes

- Development of a new material with higher wear resistance and better mechanical properties is a very interesting aspect for mechanical designers and engineers.
- A cast iron with mechanical properties closer to steel would be an important result for customers, not only because of the lower price of cast iron compared to steel, but also for its lower density (7.1-7.2 vs 7,8  $g/cm^3$ ), giving a higher performance/(weight\*price) ratio.
- Fonderie Mora could have significant advantages against competitors.



# Nanoreinforced Ductile Iron castings

## Conclusions and further works

- .- Successful procedure and technology developed for the production of Fe/nanoTiC and Fe/nanoZrO<sub>2</sub> masterpellets.
- .- Pilot scale validation of the MASTERPELLET concept. Incorporation of nanoTiC and nanoZrO<sub>2</sub> confirmed.
- .- The increase in strength does not translate itself into an improvement of the efficiency of the motor. Search of different applications.
- .- Outstanding tensile properties of IZADI 900 (nZrO<sub>2</sub>).
- .- Working on the translation of the pilot plant procedure into Fonderia Mora Gavardo. In progress. The objective is to increase the nanozirconia content and reach 900 Mpa of UTS reached in Pilot Plant castings in Tecnalía.